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REFLECTIONS ON AN F-4C INFLIGHT EMERGENCY

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PREFACE

✓ This Paper summarizes the highlights of an emergency that occurred on 1 May 1981 in an F-4C assigned to the 159th Tactical Fighter Group, Louisiana Air National Guard. The aircraft, in which the author was flying as an observer, sustained structural damage during the course of a severe out-of-control gyration caused by extremely violent uncommanded pitch oscillations during high-speed, low-altitude flight. Following these events, the aircraft was returned to controlled flight and safely landed at NAS New Orleans.

The author is a senior staff member of The Rand Corporation specializing in operational matters of concern to the tactical air forces. He was flying in the aircraft that experienced the emergency with the approval of the National Guard Bureau to enhance his appreciation of fighter employment techniques in connection with his work on Rand's Project AIR FORCE research contract. He has written previously on Soviet and Israeli tactical fighter training and is currently engaged in a study of threat issues bearing on USAF fighter force modernization. Although a civilian with no military background, he has flown extensively in numerous types of USAF fighter aircraft and is a licensed FAA Private Pilot.

↑ The portion of this Paper reconstructing the emergency as observed from the rear cockpit was submitted in earlier form to the 159th Tactical Fighter Group as a contribution to the incident investigation. This expanded version, which also dissects the author's decision sequence and attempts to extract useful lessons, has been prepared for wider dissemination to interested F-4 unit commanders, operations and safety officers, and aircrews. It has been reviewed for technical accuracy by the 159th Tactical Fighter Group and approved for publication by the National Guard Bureau.

BACKGROUND

We were a scheduled two-ship flight of F-4Cs on a routine ground-attack sortie out of NAS New Orleans, with a mission plan to fly a low-level navigation route and drop bombs on the Shelby range complex just south of Hattiesburg, Mississippi. I was riding in the rear cockpit of the lead aircraft (Jazz 21) piloted by Major John Green. Lieutenant Colonel Tony Munger and Major Billy Smith were in Jazz 22 as our wingmen. Each aircraft was configured with full internal fuel, two 370-gal. external tanks, and two triple-ejector racks carrying six BDU-33 practice bombs.

We briefed at 0820 for a planned takeoff at 1002, which slipped three minutes due to incoming traffic and a delay in receiving our departure clearance release. Following a standard formation takeoff on Runway 22, we directed our wingman out to a loose echelon position off the left side upon afterburner deselection and commenced a gentle northeasterly climbing turn to an assigned altitude of 5000 feet toward our low-level entry point, which was Grand Island in the Gulf of Mexico approximately two nautical miles southeast of Heron Bay. The weather was clear with a thick haze layer starting at around 1000 feet and scattered clouds above. We thus cancelled IFR early and proceeded visually to the hack point, letting down gradually to our planned run-in altitude of 500 feet above the water. Crossing Grand Island on a course of 076 degrees at 480 knots, I punched the clock for an initial timed leg of four minutes and 37 seconds. Since the visibility was good and all our enroute reference points were easily identifiable, we pushed up the speed to compensate for the late takeoff in an effort to achieve our prebriefed time on target of 1020.

We were level on course at 500 feet and 520 knots true airspeed, with Jazz 22 deployed approximately 6000 feet off our left wing in a tactical spread formation. I had the map in my lap, was calling off times and checkpoints to John in the front seat, and could see our initial turn point of Horn Island closing rapidly in the right quarter-panel. About three nautical miles short of the island, John and I were discussing the upcoming turn and the new heading for the next leg to

the target when the situation promptly uncorked approximately ten minutes into the mission.

THE EMERGENCY

The out-of-control gyration began with a very abrupt, uncommanded pitchdown whose onset came completely without warning. The violence of the maneuver snapped the stick forward and pinned both my hands against the canopy. The pitch angle must have been close to 30 degrees nose down, since all I could see out of the cockpit was water. This was accompanied instantaneously by a loud bang, which I interpreted to be an engine explosion, and was immediately followed by an extremely violent pitchup along with severe aircraft vibration. This second event was forceful enough to cause me very sharp and intense lower back pain and was all I needed to convince me that the aircraft was definitely out of control. We then experienced another hard pitchover which again filled my entire sight picture with water and caused me to go immediately for the lower ejection handle with both hands. I had positive upward pressure on the handle and was weighing the risks of remaining with the aircraft a moment longer versus ejecting immediately despite all the adverse conditions that prevailed (low altitude, high speed, possible high sink rate, and an extremely unfavorable body position) when the aircraft again pitched up hard and filled the canopy with sky. At that instant, I asked John over the ICS if it was time to get out. He replied, "Wait just a second," so I relaxed my pull on the handle and tried to assume some semblance of a proper body position in the seat. By this time, John had apparently regained a measure of control over the aircraft, because the pitch oscillations subsequently ceased, the vibration dampened, and we began a wings-level climb.

On reflection, it was a good thing we had the ICS on hot mike, because had John not immediately acknowledged my call or had I been unable to query him as to our status following the second pitchover, there is no doubt that I would have proceeded to eject myself out of the aircraft a fraction of a second later, notwithstanding my concern that we were probably outside the safe margin of the seat envelope. As things turned out, the positive upward vector and apparent resumption

of aircraft control took some of the urgency away from the decision, so I released my grip on the handle, ran the seat all the way down to the stops, and commenced cleaning up the aft cockpit for the controlled ejection I was still certain would be coming at any moment. (It was only hours later that I recalled having forgotten throughout the entire remainder of the flight to tighten my oxygen mask fittings and lower my helmet visor.)

Throughout the gyration, there always seemed ample time for deliberate and rational decisionmaking. All the same, it was so thoroughly disorienting that I had no presence of mind whatever to think about attempting to gather up the stick and fly the aircraft, even though I had no assurance that John was not incapacitated. By the time of the second pitchover, my sole concern was physical survival and how much time I had remaining to eject, since the combination of violent pitch oscillations, the loud explosion, and the heavy vibration all seemed to indicate that either inflight disintegration of the aircraft or impact with the water was imminent.

In the circumstances, with the severe loads that were operating on the aircraft, it was difficult to have much situation awareness of the world outside or what the aircraft was doing in relation to it. During the brief moments of uncontrolled flight, however, I did not notice any discernible yawing or rolling tendencies, even though these very likely occurred to some extent as indicated by the structural damage the aircraft was later determined to have sustained. My predominant recollection was a sensation of very hard and exaggerated pitching, as though the slab was alternately deflecting back and forth from stop to stop. The first clear impression of what was occurring outside the aircraft came during the second pitchup, when John began to take control of the situation and I saw ourselves wings-level and climbing, with our wingman about 3000 feet off to the left in a steep zoom over the top to get out of our way. (I say "the second pitchup" without any confidence that it was subsequent to that one when the aircraft was finally returned to controlled flight. There may have been additional oscillations--John could not recall the exact number--but I distinctly and vividly remember two complete cycles.)

As the aircraft began climbing and communications with Jazz 22 were reestablished, I remained convinced from the severity of the preceding events that a controlled ejection (hopefully over land) within the next few minutes was the best outcome we could expect from the situation. Although I had no fuel flow indicators or fire warning light in the aft cockpit, I was concerned that the aircraft might be burning, so I looked into the rear-view mirror for a smoke trail that would indicate the presence of a fire. Everything looked normal, so I turned to the tachometers and saw a 50-percent RPM indication on the right engine, suggesting either a rollback or a flameout. Also, our airspeed had decreased to 300 knots and was still bleeding off slowly in the climb. Our rate of deceleration must have been something to behold, since 520 knots true airspeed had been the last number I remembered just seconds before the pitch oscillations began.

We started a gentle right climbing turn to 5000 feet heading toward the shoreline. Jazz 22 joined up on our left wing to look us over. The vibration of the aircraft continued, although with considerably reduced intensity, and John proceeded to shut down the number-two engine. The G-meter was pegged both ways, indicating that we had sustained at least 10.5 positive Gs and 5 negative Gs during the course of the gyrations. At this point, I asked John for a status check. He responded that he had the aircraft under control and that we were on the way home, which was the first time since the onset of the emergency when I began to believe we might just have a slender chance of getting the machine safely back on the ground. Jazz 22 advised us that our left wing tank and pylon had separated from the aircraft, that we were streaming fuel, and that the top of our vertical stabilizer was gone. John cleared the area below and jettisoned the right tank without incident. Major Smith in Jazz 22 then suggested that we shut down all unnecessary electrical equipment on the airplane, and I turned off the radar at that time.

RETURN TO BASE

The remainder of the recovery was uneventful. Prior to crossing the shoreline on a northwesterly heading, John began dumping fuel to get our gross weight down to an acceptable level for landing. (Considering the very short length of time into the mission that had elapsed when the emergency commenced, we estimated that the left tank still contained roughly 1000 lb of JP-4 at the time it was torn off the aircraft.) Attempting to return on a direct bearing to the Harvey TACAN, John noted that his compass card had frozen (as had mine in the aft cockpit), probably due to the over-G we experienced. He then tried without avail to raise New Orleans Approach for radar vectors. We thus proceeded VFR, squawking 7700 on the IFF and descending to below 3000 feet in an effort to pick up the field visually through the haze layer, with Jazz 22 navigating for us on the wing. John then switched to tower frequency, declared an emergency, and proceeded direct to NAS New Orleans with steering advisories from Jazz 22.

We crossed the field heading west at 800 feet, extended the ram-air turbine, lowered the gear and flaps, and commenced a gradual left button-hook turn to final approach on Runway 04 with approximately 6000 lb of fuel remaining on board. Angle of attack remained on-speed or above throughout the pattern, although John had to light the after-burner on the left engine to help push us around the corner. I confirmed a gear-safe indication in the rear cockpit and we made a normal landing with a good chute. During the rollout, I raised my lower guard and assured that both our banana links were clear of loose items in the cockpit that might inadvertently fire the seats. We then brought the canopies up, pulled off into the arming area, shut down the engine, and egressed the aircraft. Total elapsed time from engine start to shutdown was one hour.

EVALUATION

Postflight examination of the aircraft and a review of events with John and the crew of Jazz 22 confirmed that the emergency was easily as serious as it appeared at the time. Major Smith had observed the entire sequence and described it as a series of extremely pronounced

angle-of-attack translations, without any appreciable variation in our forward vector of flight. He recalled noting an initial pitchdown of some 30 degrees, followed by a hard pitchup to around 60 degrees nose-high, at which time a large cloud of fuel vapor erupted from the aircraft and the left tank separated. This gyration then repeated itself, leading him to believe the aircraft was about to swap ends just moments prior to John's successful recovery to controlled flight.

The aircraft itself showed numerous signs of having endured a stressful ride. The aft portion of the vertical stabilizer above the rudder, along with the radar warning antenna, had broken away. There were lengthy skin cracks along the underside of the right wing a foot or two outboard of the wing root. The inch-thick aluminum pylon casting that had secured the left tank had sheared at both ends and was cocked some 20 degrees inboard. The upper surface of the right stabilator was noticeably buckled and delaminated from the high air loads we sustained. Finally, both engines had torn from their forward mounts and partially dropped from their supporting structure, with substantial fuel pooling in the afterburner section of the right engine.

There are residual uncertainties about what caused the emergency. It was determined, however, that the sixteenth-stage compressor disc in the right engine had separated from the shaft and been ingested by the hot section. The instantaneous loss of thrust caused by the resultant engine failure, in turn, imparted a substantial deceleration moment and nose-down pitch trim change to the airplane. Given our high airspeed, this most likely produced the initial pitchover. Moreover, the right generator dropped off the line once the right engine fell below 53 percent RPM, leading the fault protection circuits to open the electrical bus tie relay to the left generator. This may have induced a momentary random stability-augmentation input into the flight control system, which could have aggravated the gyrations caused by the sudden loss of power on the right engine.

The situation immediately prior to the first pitchover was totally relaxed, with no suggestion of impending trouble. The uppermost concern in our minds was achieving our time on target and getting good bomb scores on the range. Given the complete abruptness of the emergency,

our first task was thus to shift instantly into a problem-solving mode. My own estimate of the duration of the gyrations prior to John's regaining of control was some three to five seconds. The VGH recorder aboard the aircraft later indicated that this span was actually closer to forty seconds. Despite my respect for the accuracy of the instrument, I am still tempted to split the difference substantially in my favor. In all events, the period of time in which we were actively considering abandoning the aircraft without delay was very brief by any measure. What follows is the way I recall my reactions and the logic train that supported them.

DECISIONMAKING UNDER STRESS

The first pitch oscillation was essentially a massive attention-getter. It was at the start of the second oscillation when I realized we were in unambiguous danger and confronting an imminent decision to eject. As I mentioned above, the second pitchover sent me reflexively for the lower ejection handle. (It never occurred to me to consider using the face curtain.) At that instant, a series of vivid and conflicting flash-images began to run through my mind, producing a classic approach-avoidance decision dilemma. The first of these images was a stark recollection of all the flying safety articles I had read about crews who had delayed ejecting too long and thus failed to get out. On top of this, there was no assurance that our situation was not rapidly progressing from bad to worse. As comfortable and familiar as the cockpit seemed (despite the violent pounding) compared to the uncertainties of a high-speed, low-altitude ejection, the aircraft was plainly getting to be a place I didn't desire to be much longer. I was not at all eager to become another delayed-ejection statistic.

Offsetting this urge to get out, however, were some persuasive arguments for hesitation that kept me from pulling the handle at that instant. For one thing, for all I knew we were still transonic, possibly sinking rapidly at very low altitude, and in very dense air. My body position, moreover, was such as to almost guarantee severe spinal injury during an ejection. And we were over water, which added the risk of my coming down in the chute unconscious and drowning. Although I

never doubted the technical reliability of the seat, I did feel real momentary concern that an ejection attempt might not be survivable in the face of all these adverse parameters.

Second, the aft cockpit of the F-4 is hardly the ideal vantage point for gauging what is happening out in front. I had some doubt about the accuracy of my visual cues, particularly concerning whether or not the aircraft was descending. Furthermore, the command selector valve was set for sequenced ejection from the forward cockpit. Had it been John's choice to abandon the aircraft, I would have automatically gone first whether I wanted to or not. The fact that I hadn't told me John was still trying to salvage things and was not yet ready to give up. (As it turned out, while John was attempting to haul in the stick with his right forearm, he had his left hand on the lower ejection handle and was as ready to get out as I was.)

A final case for hesitating, which may reflect poorly on my survival instinct but requires noting, was my concern to avoid doing anything that might appear panicky or unprofessional under the cold scrutiny of the Monday-morning quarterbacks. The 159th Tactical Fighter Group was having its annual reunion that evening, and I was planning to attend. A fleeting vision thus occurred of me punching out over the Gulf of Mexico, having John land a perfectly good Phantom minus a backseater at NAS New Orleans, getting plucked out of the water an hour later, and having to take heat at the bar for the rest of the evening as a result. Good reason or bad, that seemed at the moment like something to be avoided at every cost.

It was with this confluence of mental impressions and a firm decision to eject staring me in the face when the aircraft again pitched up, bought me enough time to ask John for help, and produced the delay that led to the happy ending. However long the overall pitching sequence lasted, this thought span covered no more than a few seconds at the most. Nothing succeeds like success, and I can only applaud John's superb airmanship that got us both safely back on the ground. Yet to this day, I cannot say with confidence whether my own survival, involving a decision over which I had independent control, was mainly a consequence of wisdom or good luck.

LESSONS LEARNED

As a low-time civilian pilot (some 500 hours) with no first-pilot fighter experience, I feel myself scarcely the most competent authority on how best to profit from the sort of experience discussed above. My fighter time accumulated over the past six years has not been directed toward mastering the airplane but toward helping me to be more conversant with operational practices related to my analytical work on tactical air issues. Because of this limited background, what struck me as memorable about this emergency may appear less noteworthy to people whose daily business is fighter aviation. All the same, the emergency was a major personal learning exposure for me and generated some thoughts I would like to share with the fighter community for whatever value they may have.

Sorting the problem under pressure is not as difficult as it sounds. I cannot judge how I would have responded had this been my first fighter sortie, but for anyone with a modicum of air sense, events almost naturally impose clarity of thought in a life-threatening situation. Samuel Johnson once observed that there is nothing quite like the prospect of an imminent hanging to concentrate the mind. In retrospect, I was astonished at how measured my situation analysis was in the rush of the emergency. I certainly would never have predicted it or counted on it in advance. If this experience is a useful guide, my sense is that any catastrophic error one might be prone to make in such a situation would not be over whether to eject but over when. This leads to a corollary thought.

Don't trust someone else's judgment to keep you alive. From the moment I was on the flying schedule and we began our mission planning, I had unquestioned confidence in John Green's abilities as a fighter driver. We had flown together before, and I knew from experience that I was paired with a skilled and disciplined aviator among the best. Yet when things started coming unglued, I had no assurance that John was on top of the situation. We certainly weren't carrying on a conversation with each another during the gyration--for good reasons. But at the time, I didn't know whether to read John's silence as an indication that he was concerned with more important matters or was

incapacitated. One of the problems of not being pilot-in-command (whether in a fighter aircraft or any other) is that you can easily slip into a passive mode and depend on the other guy to do the thinking and be responsible. Needless to say, this can lead to gravely counter-productive consequences when a crisis arises. Had I experienced this emergency in a single-seat airplane, with no one else aboard to rely on, I can easily imagine that I might have skipped all the situation analysis and ejected just to be on the safe side. This is no more than speculation, but from my experience I would judge that the decision to eject when there remains the slightest ground to think twice is less confounded for the aircraft commander than for the backseater. My point here is simply to question whether my hesitation due to second-guessing about John's preferences, notwithstanding our safe recovery, was entirely well-advised given the information I had at the time.

Don't go for the ejection handle unless you've made up your mind to get out. It takes only 1-1/4 inches of travel on the lower ejection cable to fire the F-4 canopy initiator and another 4-1/2 to 5 inches after that to fire the seat once the canopy interlock block is removed. This requires a maximum 45-lb upward pull on the handle. Postflight inspection of the rear cockpit indicated that I had come within 1/8-inch of jettisoning the canopy and had consequently ridden a partially armed seat all the way home. During the peak of the emergency, I definitely put tension on the handle, but I was not aware that I had started it moving and clearly had not intended to do so. Obviously, perceptions can be very misleading in such a situation. After we landed, my raising of the lower guard did nothing to secure the seat. The slightest additional disturbance of the handle could have completed the canopy jettison sequence. In light of this, the smart solution in a future emergency would be to stay away from the ejection handle altogether until a firm decision had been reached to pull it all the way. If the handle was moved but the initiation sequence had not commenced, it would probably be wise to notify the command post during RTB that the seat was hot, stay strapped in after landing, and remain in the cockpit with the canopy down until egress personnel arrived at the aircraft to disarm the seat.

Don't worry about your image. It is a familiar refrain that a fighter pilot would rather die than look bad, but there are times when suspending pride is the intelligent thing to do. One can imagine a variety of legitimate reasons for delaying ejection in a situation such as we experienced. Concern about what the guys back at the squadron might think if you punched out prematurely is not one of them. As it turned out, we did the right thing by staying with the aircraft. John and I agreed later, however, that neither of us would have felt the slightest remorse had we opted instead to be safe rather than sorry by ejecting. You can always justify such a decision to an accident board after the event and cope with an error of judgment that kept you alive. There is no cure whatever for riding a sick airplane into the deck.